Interprovincial differences in the rates of minor crimes of violence and related disorders in New Zealand, 1853-1930: part 1

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*S. J. Haslett, M. Fairburn**

Abstract: Between 1853 and 1930 New Zealand was rapidly colonised by white settlers most of whom were British immigrants. From about the late 1870s their per capita rates of minor assaults, drunkenness convictions, spirits consumption, and civil suits fell dramatically. The paper asks whether the causal structure underlying these 'disorders' was the same in every one of New Zealand's nine provincial districts. Even though New Zealand was comparatively homogenous in ethnic and cultural terms, the character of its provincial districts varied substantially in respect to other criteria such as policing, population size, level of economic development, urbanization, industrialization and so forth. To determine if the same explanatory model fits each of the nine provinces, the paper systematically applies two forms of factor analysis to a matrix of twenty two variables in each province. The paper finds that every province had a causal structure which differed in kind from that operating in the other provinces. However, these differences were not fundamental in type.

Introduction

New Zealand from 1853 to 1930 was a frontier society which experienced rapid modernisation. Its history over this period had much in common with that of Canada, Australia, South Africa, the American west, Argentina and Uruguay. (1) Such societies have been categorised as Neo-Europes, peripheral societies, new societies, or white settler societies. Their

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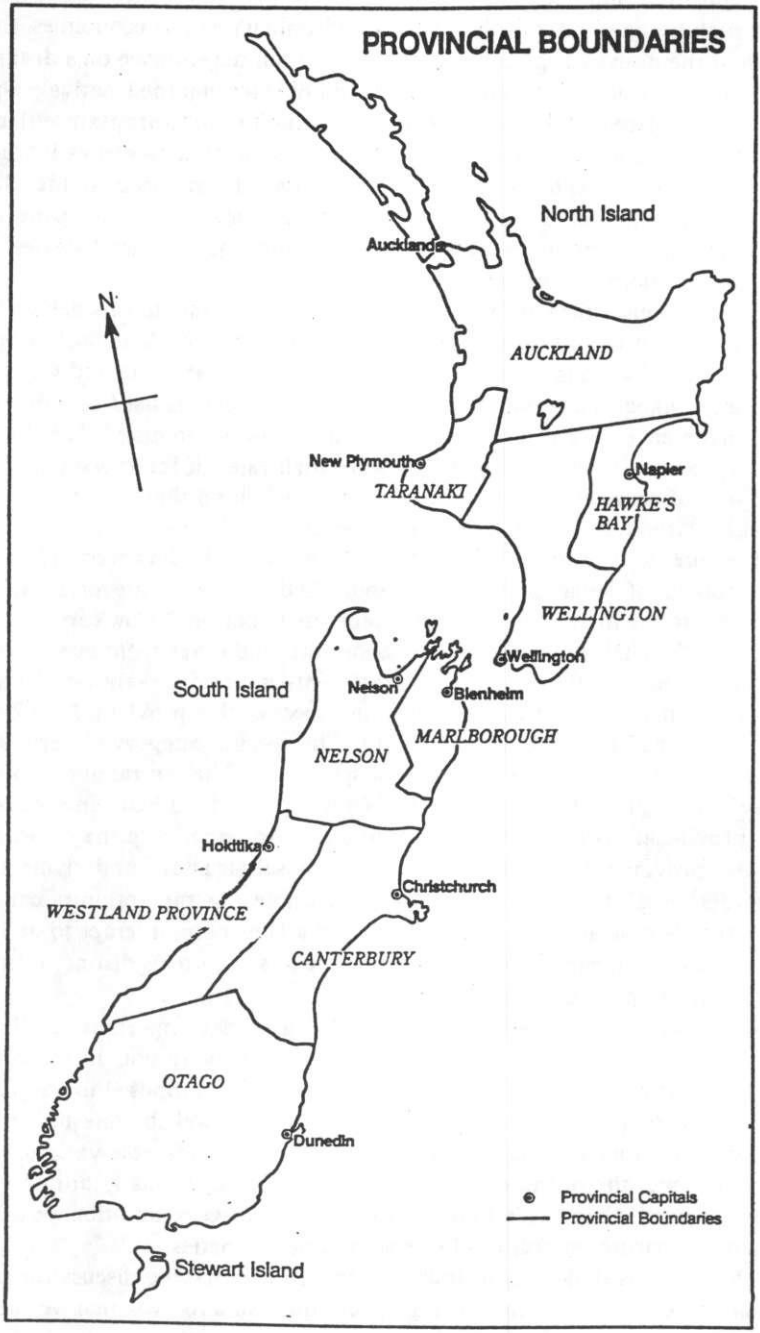
distinguishing characteristics include their recent origins, their social fluidity, high living standards, their specialised primary export economies, the myth of themselves as places of opportunity, their dependence on a distant metropolitan centre for finance capital, and the fact that their native peoples were displaced and dispossessed by large numbers of European settlers. Amongst the questions historians have asked about these societies is whether their social patterns significantly diverged from those in the Old World, and whether the crucial factor determining their social patterns consisted of indigenous circumstances, the shortness of their histories or the culture imported by the colonizers.

In a previous article (1986) we attempted to contribute to this debate by indicating that within the transplanted section of New Zealand society one particular indigenous circumstance played an important role and was powerfully linked to a certain set of 'disorders' (the term is used as a matter of convenience). We called this circumstance 'social atomism'. The disorders associated with social atomism were high rates of interpersonal conflict and of drunkenness, and the driving force behind these disorders was a set of variables which we call social deficiency. (2)

The questions that our 1986 article did not address, however, relate to the problem of deviations from the model. Did any social categories fail to conform to the model? Were these exceptions important? How can they be explained? What might they tell us about this and other frontier societies and their propensities for interpersonal conflict and drunkenness? In the following paper we explore in depth an aspect of this problem. New Zealand again will be taken as a case-study. The specific category of variation which will be tackled is the regional or spatial one. The central question we pose is this: given that New Zealand from 1853 to 1930 had nine regions (or provincial districts), did the causal structure underlying the disorders in any province differ in kind from the causal structure underlying the disorders in all the provinces treated as a whole? As the notion of causal structure is crucial to the paper, we will at a later point attempt to define clearly what is meant by a difference in type of structure as distinct from a difference in degree.

The distinction between structure and degree has important ramifications for other settler societies. If there were no variation in structure within New Zealand then, given that the mechanism proposed in our 1986 paper is a remarkably general one, 'atomism' may well be one universal aspect of frontier societies. If on the other hand, considerable variation in structure was the norm, even within a society as superficially uniform as New Zealand, then there may be little by way of generalisation possible when comparing geographically separated new societies.

The paper is divided into four sections. In the first we discuss the original model since it is this which provides the standard by which we judge


PROVINCIAL BOUNDARIES
North Island
Auckland
N
AUCKLAND
New Plymouth
TARANAKI
Napier
HAWKE'S BAY
WELLINGTON
Wellington
South Island
Nelson
Blenheim
MARLBOROUGH
NELSON
Hokitika
Christchurch
WESTLAND PROVINCE
CANTERBURY
OTAGO
Dunedin
Provincial Capitals
Provincial Boundaries
Stewart Island

the extent of New Zealand provincial variations. The next section covers definitional and other ancillary problems. The third section spells out the technique we have devised to compare in a systematic fashion the variable structure of the nine provinces. The reader will find that our technique is not based on micro-methodology but on a form of multivariate statistical analysis. (3) In the last section we discuss our detailed findings; the detail stems from a need to indicate the workings and possibilities of our somewhat novel technique for comparing structural models, and to clarify the extent of variability within New Zealand and its consequences for interpreting structure within other new societies.

I

Annexed by the British crown in 1840 and awarded parliamentary self-government in 1852, New Zealand was a colonial settler society of very recent origin. While there was certainly friction and even occasional wars between the settlers and the indigenous Maori tribes as a result of incompatible cultural differences (particularly in relation to the meaning of the land, its ownership and sale) the effect of these differences on the development of the settler population does not seem to be reflected in the government statistics available for use in this study. Partly because of their physical isolation from most settler institutions, the Maori population had a negligible effect on the disorder statistics, particularly in the early years. New Zealand's white population rose slowly from 2,000 in 1839 to 26,000 by the 1850s, and, after expanding quickly to reach 800,000 by the 1880s, finally reached one and a half million by 1930. Convicts, slaves and indentured labour were never a part of the immigration flow. Settlers were largely English and Scottish in descent and Protestant in religion. Ethnically, they were more homogenous than Americans and Australian colonists; culturally, they maintained very close ties with the parent society. Under the stimulus of gold discoveries in the 1860s, the expropriation of land from the Maori tribes, and the establishment of highly efficient forms of export-led agricultural and pastoral production, the economy grew rapidly and encouraged the swift development of small-scale urbanization and manufacturing. With some justification, colonists liked to portray their society as 'the land of milk and honey', the 'social laboratory of the world', the 'Brighter Britain of the South'. Throughout the 1853-1930 period they probably enjoyed one of the largest rates of real property ownership and of national income per capita in the world. They were never invaded or threatened with invasion. They very rarely suffered from collective violence with the exception of the wars of the 1860s between the government and some of the Maori tribes. Compared with most other

modernising societies, the state in New Zealand was both closer to the individual and stronger. Democratic rights were quickly extended (all men were enfranchised in 1879, all women in 1893). The powers and responsibilities of central government expanded rapidly in such areas as policing, criminal justice, economic development, the distribution of opportunities, the control of privilege, schooling, working conditions and wages, and welfare. (4)

But white settler history was not only characterised by prosperity, egalitarianism and relative freedom from civil strife. It was also distinguished by a curious pattern of interpersonal violence. Our 1986 article started with the observation that up to the late 1870s the levels of four indicators of violent crime - charges per 100,000 for common assault, for assaults on the police, for woundings, and for homicide - were higher than at any other time in New Zealand history, and, even allowing for demographic differences, were appreciably higher than they were in England, the place of origin of most immigrants. And yet from various points subsequent to the late 1870s, all these indicators of interpersonal conflict dropped very markedly, and by the late 1930s were a tiny fraction of their mid-19th century peaks. We asked why violent crime in New Zealand followed such dramatic trends and whether the causes of interpersonal conflict in this new society were the same as those which historians in older societies had found or were debating. When trying to explain these long-term trends we found that they were little affected by secular changes in the control structure, by possible errors and shifts in recording and collating practices, and by changes in the proportion of young adult males in the population, the category often assumed by criminologists to be 'most at risk' of deviance. We then used a probability-based analysis to reconstruct the ecology of the offending population (hereafter this is called the 'global analysis'). We took annual data for thirty or so variables for each of New Zealand's nine provincial districts for the 1853-1930 period, pooled all these provincial data, and examined the pooled data using scatter-plots, Pearson correlations and a factor analysis of the correlations. In the absence of readily accessible provincial statistics for all four possible violence indicators, the choice of the violence variable had to be restricted to summary convictions for offences against the person per 100,000 population. As the raw data for the violence variable were only recorded between 1853 and 1930 this set the chronological limits for the analysis.

The results of the analysis showed that the violence rate was very strongly and positively correlated with the rate of summary drunkenness convictions per 100,000 population, gallons of spirits consumed per capita, and the rate of civil suits per 100,000 population. As there were good empirical reasons for believing that the all four variables were functionally related, we hypothesised that all four were symptomatic of a common underlying malaise which might also be apparent in the other variables analysed.

Three variables (and their derivatives) had the highest positive intercorrelations with each of the four disorder variables, and all were powerfully and positively intercorrelated with each other. What they represented (at least in the New Zealand context) were deficiencies in the social organization. All followed the same long-term trends (at the national level) as the disorder variables: they were at their historical peaks before the late 1870s and fell very sharply thereafter. One was the ratio of adult females to adult males (a proxy measure of the density of kinship ties); another was the proportion of overseas-born in the population (assumed to be one of the most disaffiliated elements in the general population); the third was the ratio of dwellings of one to two rooms (predominantly tents and makeshift shelter) to total dwellings (which in other societies is often taken as a measure of poverty, but in the New Zealand context is a good indicator of extreme transience and new areas of settlement). (5)

On the basis of these statistical patterns and drawing extensively on other data we postulated that the dominant causes of assaultive behaviour, excessive drinking and litigation were weak and thin patterns of association. The problem originated during the period from the 1850s to the late 1870s when most of New Zealand's hinterland was rapidly opened up and gold-rushes and the lure of large and cheap sources of land sucked into this thinly and newly settled hinterland wave upon wave of immigrants. The great peopling and territorial expansion of New Zealand interacted to atomise the society. On the one hand, the great peopling meant that the vast majority of colonists were recently uprooted immigrants, most of whom came as individuals or in nuclear family groups and therefore had left all or most of their affiliations behind them. On the other hand, the movement of these immigrants into newly settled areas retarded their capacity to fill these associational gaps. In the new areas there were few established networks and voluntary organizations which newcomers could plug into, rates of transience were extremely high, households tended to be geographically isolated, kinship ties were in short supply and restricted in range, and abundant opportunities for material independence thwarted the development of client-patron relationships. Reflecting these trends, the overseas-born comprised between 50 and 75 per cent of the population, the national ratio of adult males to females peaked at 2.3:1 in 1864, and in 1867 about half the national housing stock consisted of tents and other extemporised forms of shelter. In turn these forces of atomisation deprived settlers of the informal machinery of control which in older, more established, societies play a vital part in maintaining social order at the local community level. (6) Although the state was relatively strong and although immigrants brought from Europe a basic code of self-restraint (or 'civilising influences', to use the phrase of Norbert Elias (7)), most colonists lacked the capacity to restrain one another within the context of commu-

nity frameworks of reciprocity and surveillance. Unlike David Flaherty's model of 18th century Massachussets, primary bonds in localities were too few and too weak to deter excessive drinking and provide less harmful means of recreation, to communicate and clarify norms, to prevent disputes by curbing predatory behaviour, and mediate in disputes. (8)

From the late 1870s onwards, however, a sharp drop in the pace of territorial expansion and consistently low rates of immigration allowed the society to 'settle down'. As indicated by the falls in the ratio of adult males to females, in the proportion of small makeshift dwellings, and in the percentage of the overseas born, the effects of atomisation quickly receded. A growing proportion of colonists became integrated into an expanding array of groups and networks in local communities where their disputes were handled by informal mediators and where their lives were closely supervised and subject to the sanctions of gossip, ridicule and exclusion. As this thickening net of informal social regulation was extended over the population, it produced a long-term diminution in the scale of each disorder variable.

II

Having outlined our social atomism theory and its empirical foundations, let us return to the issue of the extent of provincial variation on or from this theme. Looking objectively at the methodology of the global analysis, we would have to say that one of its more obvious weaknesses is its neglect of provincial particuliarities and spatial diversity. Since the model is based upon pooled data taken from each of New Zealand's nine provinces, it generates a comparatively large number of observations (up to 702 per variable). In a statistical sense the advantage of this procedure is that it lessens the effect of possible quirks in the data. Explanatory generalisations based on 702 data points are obviously on firmer ground than those based on a smaller number of data points. But in a historical sense the disadvantage of pooling is that if it does minimise the influence of possible quirks in the data it may also smooth out (and mask) the possible existence of provincial variations in structure. As each province contributes up to 78 observations per variable, there is obviously a chance that in one or more of the provinces the causal structure underlying the rates of petty violence convictions, of drunkenness convictions, of spirits consumption and of civil suits was different in kind from the causal structure postulated for the global model. (9)

The *prima facie* evidence in favour of this possibility is certainly not strong. Although historians have insisted that New Zealand was a regionally diverse society, they agree that regionalism was weaker than in most

other societies and that its influence was much more important up to about the 1880s (a minor part of the period) than in subsequent years (the bulk of the period). (10) More importantly, New Zealand had none of the obvious characteristics which might reasonably be expected to produce marked spatial deviations from our ideal typical or global model. For one thing, it was a small-scale society. Its population was minute, its land area was very small, and its regional units were correspondingly few (nine provinces as against France's 86 Departments). For another, it was (comparatively speaking) a culturally homogeneous society. None of the provinces was dominated by a particular linguistic, ethnic or religious sub-culture (one of the first things historians look for to explain spatial variations in crime patterns). The cultural homogeneity stemmed partly from the youthfulness of the country and partly from the preponderance of the British-born in the immigrant population and their rapid growth. The largest minority group, the indigenous Maoris, comprised an average of only 11 per cent of the total population over the 1853-1930 period. And although their distribution varied sharply from province to province, the amount of recorded Maori involvement in the disorders was so slight that it has no capacity to give rise to and explain provincial deviations. The second largest ethnic category, the Irish-born (Catholic and Protestant), constituted merely six per cent of the total population, 1853-1930, and was fairly evenly spread over the nine provinces (the provincial averages varied between five and 10 per cent percent). (11) On top of this, the coercive powers of the central government grew very strongly from a relatively early point in New Zealand's history. Another obvious thing therefore that one would expect to produce spatial deviations from the global model - a decentralised control response to the disorders - was not a prominent aspect of the period. During the early years (1853 -1876) a quasi-federal constitution permitted the establishment of a highly diverse collection of provincial prison regimes and professional police forces and some interprovincial differences in the drunkenness and vagrancy laws. (12) But this regional system of government was abolished in 1876 and thereafter the country had a single and national police force, prison system, and code of criminal law. Over the whole period, moreover, the courts were under the sole charge of the central government.

Against all this, a little probing of the statistical data supports the possibility that the causal structures underlying the disorders in some provinces differed in type from the structure postulated by the global model (hereafter such provinces are called exceptional provinces). Certainly the results of this superficial analysis do not lead one to believe that any exceptions (i.e. of kind) would be as gross and clear-cut as those produced by other societies. The results are diffuse and ambiguous: they do not necessarily prove the existence of exceptions nor are they capable of identifying

the form and location of the exceptions. But the evidence has to be taken seriously since it indicates that, despite the prima facie case, the likelihood of such exceptions was appreciably greater than the likelihood of non-exceptions.

To begin with, the likelihood of exceptions is implied by the wide dispersion of interprovincial values on each disorder variable. By itself the wide dispersion does not necessarily point to divergences in type from the global structure; it could also mean that the provinces had the same underlying causal structures which varied in degree (or strength) from province to province which in turn generated the wide dispersion. Even so, a wide dispersion at least does not exclude the possibility of provincial exceptions, and provides stronger evidence for exceptions than had the dispersion been a narrow one. Time series plots (figures 1-4) show that the interprovincial range of rates on each disorder variable was greatest in the years up to the late 1880s and then tended to diminish sharply from that point onward. Table 1 summarises the overall pattern by giving the average for each variable in each province over the whole period. From the Table it can be deduced, for example, that from 1853 to 1930 the average annual rate of spirits consumption was three times greater in the thirstiest province than it was in the most sobre one.

Another and stronger test of provincial exceptions is that the rates of the disorder variables in some provinces (relative to all the other provinces) appear to be disproportionate to the rates of their social deficiency variables (relative to all the other provinces). This test assumes that if the social deficiency variables were the main causes of the disorder variables in each of the nine provinces, it is reasonable to expect the relative strength of their respective disorder variables (expressed as averages, 1853-1930) to be commensurate to the relative strength of their respective social deficiency variables (expressed as averages, 1853-1930). Hence if in any province a major inconsistency between the relative levels of the two sets of variables were found, this would suggest that its disorder variables were affected by different kinds of causes than those driving the violence, drunkennness civil suits, and the spirits consumption variables in the global model. Turning now to the provincial rankings on the two sets of variables in Table I and Table II, we can see in fact that there are major inconsistencies. The limitation of the two Tables is that the provincial rank-orders are derived from the average annual rates over the whole period, and many provinces have averages that are tightly packed around the middle of the interprovincial range. Even so, in particular instances the magnitude of the inconsistencies seems too big to be ignored. The most blatant example is Wellington province. On the one hand, its three social deficiency variables were among the weakest of the nine provinces. On the other hand, it had the highest average rate of violence convictions, the highest average rate of

TABLE I

Average values of the annual rates of policing, drunkenness convictions, petty violence convictions spirits consumption and civil suits, 1853-1930

	Police Rate		Drunkenness rate		Violence rate		Spirits rate		Civil suits rate	
	Value	**Rank**	Value	**Rank**	Value	**Rank**	Value	**Rank**	Value	**Rank**
Auckland	84.6	**8**	1599	**2**	185.3	**3**	0.77	**6**	4098	**9**
Hawkes Bay	106.2	4	1361	**3**	160.6	4	1.02	4	5405	**3**
Taranaki	82.8	**9**	785	**7**	121.8	**9**	0.41	**9**	5148	4
Wellington	115.6	**2**	1814	1	217.5	1	1.25	**3**	5479	**2**
Marlborough	89.0	**6**	634	**8**	131.0	**8**	0.51	**8**	4646	**6**
Nelson	87.1	**7**	616	**9**	148.0	**5**	0.70	**7**	4260	**7**
Canterbury	89.8	**5**	1066	4	144.0	**6**	0.99	**5**	4655	**5**
Westland	143.8	1	981	**6**	203.2	**2**	1.71	1	6073	1
Otago	110.4	**3**	989	**5**	136.9	**7**	1.31	**2**	4251	**8**

Note: A province with a rank order of 1 had the highest average value, a province with a rank order of 9 had the lowest average value. For description of variables see appendix.

drunkenness convictions, and was near the top of the provincial league for civil suits and spirits consumption. Such a pattern suggests that some mechanism additional to the three main variables measuring deficient social organization pushed up the rates of the disorder variables in Wellington to a much greater extent than it did in the rest of the provinces and, by implication, in the global model.

On balance, then, there is sufficient prima facie evidence to support the possibility that provincial exceptions to the global model existed, even though their identity is not self-evident and even though they may be relatively minor in relation to those produced by culturally complex societies. Put in this way, however, the hypothesis begs its own questions. If in some provinces the causal structure underlying the disorders was different in type from the causal structure postulated by the global model, how can these provincial exceptions be discovered if their existence is in some doubt and their character is uncertain? And if they are found, how can their status as exceptions be justified if they were relatively minor? In order to answer the question, two problems must be confronted.

Firstly, there is the thorny problem of taxonomy, definition, and categorization - what would constitute an exceptional province? How can we distinguish between a provincial causal structure that differed in kind from the global type and one that differed in degree from the global type? If a provincial causal structure was different in kind, how would we tell if it was fundamentally distinctive, and how would we tell if it was not so fundamentally distinctive and belonged to a global sub-type? Given that there has been so little discussion of these sorts of questions in the social sciences, there is little choice but to proceed heuristically, taking a few guiding and provisional principles as the starting point.

As indicated at the beginning of the paper, our objective is to identify provincial causal structures that differed in type or kind - not in degree - from the global structure. This, as we see it, excludes the most obvious possibility. We would not classify a province as different in kind if the only difference between it and all the provinces combined was that it had a higher or lower density of associations and atomised people. Thus, relative to the global model, a province that has abnormal rates of the three social deficiency variables (the percentage of the overseas born, the ratio of adult males to females, and the ratio of small to total dwellings), does not necessarily vary in kind from the global type. In fact our global model is simply one in which variation between provinces is restricted so that relativity between two different provinces is fixed regardless of the variable considered. By themselves, very high (or very low) levels of the three social deficiency variables in conjunction may well constitute differences in degree only. Certainly, we do not deny that there were marked disparities in these levels, especially in the early years, and that some provinces had

TABLE II

Average values of the annual rates of overseas born, ratio of dwellings with one and two rooms to total dwellings, and ratio of adult males to adult females, 1853-1930

	Percentage of overseas bom		Ratio small to total dwellings		Ratio adult males to adult females	
	Value	**Rank**	Value	**Rank**	Value	**Rank**
Auckland	45.9	**2**	0.177	**6**	1.32	**7**
Hawkes Bay	46.1	**1**	0.218	**5**	1.61	**4**
Taranaki	39.7	**7**	0.167	**7**	1.40	**6**
Wellington	41.3	**6**	0.157	**8**	1.29	**8**
Marlborough	34.7	**9**	0.222	**4**	1.70	**2**
Nelson	39.4	**8**	0.262	**2**	1.62	3
Canterbury	44.2	**4**	0.143	**9**	1.22	**9**
Westland	42.5	**5**	0.344	**1**	1.95	**1**
Otago	45.8	3	0.250	3	1.54	**5**

Note: A province with a rank order of 1 had the highest average value, a province with a rank order of 9 had the lowest average value. For description of variables see appendix.

much higher or lower aggregate levels of informal community control than the global average (see Figs 5-7 and Table II). But the crucial test for a different kind of causal structure is something else, namely, whether the long-term rates of all the variables in a province (including those expressing social deficiency, the lesser causes, and the disorders) were reasonably proportionate to the long-term rates of the same variables in other provinces. If they were not, then the provincial causal structure is different in kind.

In this context a province would possess a fundamentally different kind of causal structure if the province displayed one of three characteristics. First, its disorders would have to be linked to a set of variables that have nothing in common with those we used in the global analysis. Second, at least one of its social deficiency variables would have a negative relationship with one or more of its disorder variables. Thus whereas in the global model each one of the social deficiency variables has a positive relationship with each one of the four disorder variables, in a province with a fundamentally distinctive causal structure the opposite would be the case. Third, the province would possess an extremely abnormal secondary mechanism that not only had a negative relationship with the disorders but was so powerful that it completely overwhelmed a positive relationship between social deficiency and the disorder variables.

A province with a causal structure belonging to global sub-type would not exhibit any of these extreme characteristics. But the weightings of the elements in the causal structure in relation to the weightings of the disorder variables would be significantly different from those in the global model. For example, even though the province may have the same per capita amount of social deficiency as all the provinces combined, its rates of disorders will be markedly dissimiliar. The reason for this is that it contains an abnormally large (or small) secondary mechanism in its causal structure. The abnormal mechanism may directly influence the disorder variables or its effect on them may be mediated through the social deficiency variables. In either respect, the abnormal mechanism pushes the disorder rates out of line but not in a way that leads the whole causal structure to have a negative relationship with any of the disorder variables over the long-term.

A province with a causal structure that differed in degree only from the global type would have two characteristics. First, the relativities between all its variables would be very similiar to those for all the other provinces combined. Second, the magnitude of its variables would be significantly different from those for all the other provinces combined.

Lastly, there is the case of a province that was both the same in type and in degree as the global type. Both the relativities between its variables and their magnitude would be very similiar to those for all the other provinces combined.

Apart from the definitional problem, the other question that must be tackled is the technical one. What instrument should be employed to combe-out the exceptional provinces and to establish their exact differences in form? The device has to make fine distinctions and systematic comparisons between each province, and between each province and the average of all the provinces, in terms of a large number of variables some of which are assumed to act as groups and all of which are interrelated parts of the colonial world. Moreover it has to be able to distinguish between subtype variations and fundamental structural difference. The method that best suits these requirements, we feel, is a variety of factor analysis. As our discussion of this in the following section is of a technical nature, the layperson may find it profitable to move instead to section IV where the results of the procedure are discussed.

III

What follows below elaborates statistical techniques which are novel in their application to historical data; these are detailed to provide a possible template and also to make the working which has led to our conclusions comprehensible. (13)

While we have used factor analysis as our principal tool, this is only one of a number of statistical techniques that may be applied to historical data; for continuous, rather than discrete or categorical variables, possible alternatives include multiple linear regression, (multiple) time series analysis, principal components, and measurement error models. Nearly all these techniques assume that the underlying model is linear in the variables under study. Multiple linear regression and time series techniques are essentially predictive; principal component models and factor analysis allow models without a specified dependent variable to be fitted. Generally speaking only measurement error models and factor analysis can be used where variables are measured with error (14)*; for mathematical details for the factor analytic case see Appendix 2A.

One way of determining the difference between structure and degree is to ask an alternative question: 'Is there a difference between the factor loading matrices of two possible factor models?' Other definitions of difference of structure are of course possible; indeed this was the tenor of the comments on taxonomy, definition and categorization in the second sec-

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* *Editor's Note:* For reasons of space only, nearly thirty pages of detailed mathematical dicussions and several tables and graphs attributed to in the text and in the following notes had to be excluded. Please consult the authors directly for these materials (Appendix 2 — 4; Tables A-I — A-VI).

tion of this paper. In general the use of factor analytic models to determine structure may not be without problems; for example, the existence of a factor analytic solution for a given covariance matrix is not guaranteed. Alternative definitions of underlying structure may have merit, and other techniques may in the end prove to have wider general applicability. The answer to the question of how to best determine underlying structure in historical data should, we believe, continue to be a subject of enquiry. It would, however, seem that an answer is unlikely to become clear until further historical data bases have been analysed, even if the philosophical issues are resolved; there is no guarantee of a unique optimal strategy from a statistical viewpoint. The essential caution, in any event, is that our original question of differences in structure and degree between provinces has, in our paper, been encapsulated as a more technical question: 'For each province, is there any significant difference between the factor model which best fits all provinces taken together, and separate factor model fitted to the particular province?'

Suffice to say that we are aware that other definitions of structural difference are possible, and do not wish to subordinate these issues to their context in a statistical model. Given the rich data source that the New Zealand provincial information provides, we are however also mindful that statistical modeling allows us to test and refine answers to at least the central questions, those of possible differences of kind or degree, that have motivated our study. Our central hypotheses might otherwise remain largely conjecture; of what we are less certain is our interpretation when discussing the role of particular variables in particular provinces.

The nine provinces which serve as the framework of the analysis are the same nine (see map) which provided the pooled data for our 1986 paper. The variables are the same as well except for those expressing change rates, growth rates, and percentage of Maoris (the indiginous population), all of which have been dropped. (15) Rate variables were used in the analysis to adjust for the otherwise distorting effect of population size on provincial data for violence, drunkenness etc. Rates and correlations between rates have been used previously. (16) The choice of variables, by including groups which although similar are not related linearly, extends the essentially linear nature of factor analytic models to linear functions of variables which are related in a non-linear fashion. (17) For ease of interpretation all variables were scaled by their global means before undertaking the factor analyses. This is simply a rescaling of all of the factor analyses each by the same amount; conclusions from the analyses are unaffected. Since global means were used, the scaling is identical for each province, and for constrained and unconstrained analyses. This has the interpretative advantages that factor loadings for different variables are more easily compared and that covariances between rate variables were approximately the same order of magnitude. (18)

There are some further mathematical details to be disposed of. Appendix 2B is central in that it considers the relationship between a factor analysis model for the covariance or correlation matrix of combined data from several groups and the equivalent factor analysis for the covariance matrix from each group separately. It is shown there that, under fairly general conditions, for groups with possibly different population means, the structure implied by the existence of an overall factor model is a structure in which the factor loading matrix for each group is simply a scaled version of the overall factor loading matrix. The scaling affects the columns of the loading matrix so that all elements in the same column are scaled equally.

The relationship between the global factor analysis in our 1986 article and a model with the same factor structure fitted to each province is thus an example of the mathematical connections discussed in Appendix 2B. The model for each province is allowed some freedom in that for the same variable each province is allowed a different mean value; the specific variances are allowed to be unequal for different provinces and the same variable; the factor loading matrix is also allowed to be scaled differently for each province. What remains invariant is the factor loading matrix itself. Taken in conjunction, this means that we are assuming provinces to have the same underlying structure even if they have different long-term averages for the same variable and different amounts of variability about such mean values, so long as the structural part of each variable in the analysis (as encapsulated in an identical factor loading matrix for each province) moves up and down together to the same degree, i.e. in exactly the same ratio or proportion within each province for each variable; such an analysis is a confirmatory factor analysis given the work in our 1986 article. The global factor analysis in the 1986 article looked at a single global model fitted to all the provincial data combined. In effect this analysis ignored information on the province to which a piece of data belonged, and fitted a single global mean for each variable before fitting a factor model. Perhaps the surprising conclusion of Appendix 2B is that, despite the possibility of scaling and different means for the same variable in different provinces, our 1986 global analysis and the model which is equivalent (under certain specified conditions), indicate an identical underlying structure for each province, with identical factor loading matrices, except for two rescalings, one scaling all elements in a particular column of the factor loading matrix for each province by a single scalar, and the other due to analysing covariance rather than a correlation matrix. The 'identical structure' model is a confirmatory factor analysis in that, under certain assumptions, the structure is set by the global model and we seek to confirm this structure for each province separately.

The model with which this 'identical underlying structure', or constrained, model is compared, is again a factor analysis, this time with all of the

variable means, the scalings of the columns of the factor loading matrix, and the factor loading matrix itself, allowed to differ for each province. In fact, because all the elements of the factor loading matrix are unconstrained, the scaling factors can all be set to be one without loss of generality. The 'different structure' model is an unconstrained factor analysis. (19)

The best model fitted, both constrained and unconstrained, for each of the nine provincial districts, was a one factor model. (20) The magnitude of the residuals from fitting one factor models to the covariance matrices for each province, particularly for the unconstrained factor analytic models, make it clear that any second factor, even if it existed, must be a minor part in the structure of the analysed covariance matrix in the New Zealand case, and must therefore play only a minor part in the explanation of underlying phenomena.

The factor loading matrix for each province for both the constrained and unconstrained analysis is contained in Appendix 3, Tables ATI and A-IV respectively. Note that in these tables each column corresponds to a factor loading matrix for a separate factor analysis, making 18 factor models in total, nine constrained and nine unconstrained.(21) For almost all variables, any sizeable factor loading associated with a particular variable has the same sign for both constrained and unconstrained factor models for a given province. Departures from underlying structure are not therefore gross departures. Variations on some global subtype seem to be the rule, since for every one of the nine provinces the unconstrained factor model is a significantly better fit than the constrained factor model. (22)

This provides the bedrock of our findings: at least some provinces have different structures which are variants on a global theme. On a more tentative basis, we now seek to explore how we might discover how particular provinces differ from the global type.

Thus, as well as being able to compare the overall fit of two factor models for a province, we require some method of determining which particular rate variable or variables are contributing most strongly to that difference, given a significant difference in fit. The technique used here follows from work by Anderson and Amemiya who have shown that the asymptotic standard errors of the estimated factor loading coefficients (and hence their estimated variances) computed by standard computer packages are valid for virtually any type of non-normal factor analysis. (23) Thus by fitting a factor analysis using maximum likelihood and estimating the standard error for each element of the factor loading matrix, estimated standard errors for the estimates of the factor loading coefficients from the same model fitted instead by unweighted least squares can be derived, since corresponding elements have equal asymptotic standard errors. Given two models with the same number of factors but with at least one different factor loading coefficient, fitted to the same data, statistically

significant differences can be found at say the 5% level, by taking twice the standard error for the difference, and testing whether this value exceeds the absolute magnitude of the difference in the associated coefficients; if it does so, the difference between the factor loading coefficients, which correspond to a particular variable, is significant at the 95% level. Different multipliers allow significance tests at any preset level. (24)

The important question that the differences in factor loading matrices thus allow us to address is »Which variables for each province are the ones requiring the greatest adjustment or reweighting in the improved unconstrained model when compared to the constrained?« The reweighting is an indicator of which variables are more (or less) important in the individual province vis-a-vis the global (i.e.constrained) model and is determined directly from the differences in factor loading matrices. These are tabulated in Table III, where significant differences in each of three ranges, less than 0.01%, between 0.01% and 0.05%, and between 0.05% and 0.1%, are highlighted, the extent of highlighting depending on the statistical significance of the difference; necessary details are footnoted to Table III.

Factor loading matrices, together with the estimate of the covariance matrix from the factor analysis, and a number of estimated scalars, allow us to estimate factor scores. Factor scores should not be confused with factor loadings. Factor scores are constructed for each factor in a factor analytic model as a linear combination of the variables fed into the factor analysis. Such factor scores can be determined by two different techniques (25), but whichever one is used the salient point is that the relationship between each variable and the factor score, as indicated by a plot of a scaled factor score against the variable itself or by their correlation, provides information on how closely each variable is related to the particular factor. For each factor in a multifactor model, the scaling of the factor score that best fits a particular mean adjusted variable is simply the appropriate element in the factor loading matrix. For time series data, plots of factor scores against time, by providing a diagrammatic representation of the development of each underlying factor, are a useful interpretative tool. (26) For our data the yearly sequence of factor scores indicate the development of the underlying factor over time for each province; because our factor scores generally transit monotonically from high to low values (except for example during the gold rush periods) we have chosen to call our single factor 'atomism'. The connection between this central factor and 'atomism' is semantic, not statistical.

Positive differences in Table III indicate that the factor loading coefficient for a particular variable for a particular province weighs the estimated factor score in each year more heavily than the global average across provinces; negative differences indicate the opposite. Each factor

TABLE III

Differences between factor loading matrices -Unconstrained less constrained One factor per province

	Ad	HB	Tara	Wgtn	Marl	Nelson	Cant	W'd	Otago
Violence	0.201	0.126	0.091	***0.513***	0.243	***0.466***	0.077	-0.151	-0.060
Drunkenn's	***0.376***	0.172	0.067	0.150	0.037	***0.239***	0.064	***-0.203***	***0.258***
Overseas b.	-0.016	-0.023	-0.045	***-0.057***	***-0.084***	-0.032	-0.076	0.052	-0.059
Irish born	***0.313***	0.024	0.074	0.054	-0.021	0.083	-0.025	0.008	***-0.173***
Adult males	***-0.081***	-0.029	***-0.056***	***-0.075***	0.009	0.055	***-0.062***	0.022	*-0.036*
Adult females	***-0.082***	*-0.072*	***-0.071***	***-0.130***	***-0.095***	-0.031	*-0.072*	***0.066***	*-0.072*
Ratio men to women	*-0.045*	0.022	-0.014	0.016	***0.145***	***0.145***	***-0.061***	-0.024	-0.018
Urban pop.	***-0.082***	-0.042	0.044	***-0.126***	-0.013	***0.129***	***-0.119***	0.019	-0.048
Males 21-40	-0.035	*0.075*	-0.037	-0.021	***0.119***	***0.180***	0.037	-0.071	0.047
Small dwllgs	-0.128	-0.183	-0.064	0.102	0.072	0.133	***-0.256***	0.091	-0.141
Total dwllgs	-0.056	***-0.093***	***-0.048***	-0.020	***-0.037***	-0.008	***-0.100***	***0.065***	***-0.086***
Ratio small to total dwllgs	0.005	0.047	0.060	0.149	***0.191***	0.147	-0.020	-0.084	0.084
Spirits cons'n	-0.048	0.105	***-0.203***	0.171	0.063	-0.143	0.082	0.017	0.064
Beer cons'n	0.034	***0.116***	-0.038	***0.124***	***0.245***	***0.224***	***0.199***	-0.056	-0.215
£ imports	***-0.575***	-0.106	***-0.240***	***-0.828***	-0.069	***0.216***	-0.268	0.112	-0.076
£ exports	***-0.388***	***-0.587***	***-0.764***	***-0.663***	-0.139	***0.220***	***-0.235***	0.176	-0.057
Manufact'g HP	***-0.507***	-0.042	-0.333	***-0.594***	0.200	***0.426***	0.042	-0.086	-0.016
Manufact'g Employees	-0.043	0.082	-0.013	***-0.220***	***0.287***	***0.207***	-0.095	-0.047	0.002
Police numbers	***-0.116***	0.048	*0.112*	0.013	0.078	***0.126***	0.068	-0.050	-0.001
Immigration	-0.238	0.318	-0.138	*-0.685*	-0.179	-0.162	0.539	-0.171	0.404
Emigration	***-0.465***	***-0.393***	***-0.268***	***-1.453***	***-0.306***	***-0.395***	***-0.278***	0.382	-0.176
Civil suits	***-0.245***	*0.181*	0.022	*0.154*	0.195	0.236	0.205	-0.044	-0.044

Notes: Ad = Auckland HB =Hawke's Bay Tara= Taranaki Wgtn=Wellington Marl=Marlborough Nelson=Nelson Cant= Canterbury W'd= Westland Otago=Otago.
For description of variables see appendix. Except for ratio data, all variables are expressed as proportions of population, or as rates per 100,000.
Although the particular differences between factor loadings are tabulated relative to the variables for which they are loadings, the table refers to factor loadings rather than variables, per se.

significance level < 0.000100
0.000101 < significance level < 0.000500
0.000501 < significance level < 0.001000

loading coefficient when multiplied by the (scaled) factor score for each year (which has a unique value for the constrained factor analysis and a unique value for the unconstrained analysis, in every year for a given province) indicates the best factor analytic estimate of the particular mean adjusted variable. By the standards of the global model, a positive difference means that the function of that variable in the provincial environment is greater than expected. What this indicates for a particular variable may involve both its relative level and relative variability, where the relativity is defined by reference to the structure of the global model. An inherent difficulty is that a positive difference in factor loading coefficients may have a number of possible interpretations, ranging from the variable having a higher than expected level, to its having greater than expected variability. Each factor analysis for each province tries to adjust for both of these for a given variable by use of a single factor loading coefficient; where higher than expected level is found in combination with lower than expected variability, for example, interpretation is not always straightforward. Variables which are poorly fitted by the factor model (in terms of the magnitude of the correlation between the variable and the factor being less than 0.7) also complicate interpretation. (27) So do variables which are not consistent in their behaviour over the whole period, relative to the underlying factor; factor loading coefficients tend to measure 'average' behaviour. Nevertheless these complications are not general. By contrast, a negative difference indicates that the variable makes up a smaller part of the province's structure than it does in the global structure. Significant positive and negative differences between constrained and unconstrained coefficients correspond to differences in structure, rather than differences in degree.

A statistically significant difference in factor loading coefficients for a given variable is not sufficient to imply a causal relationship between the variable and the underlying factor in that province. The factor models also assume homogeneity of behaviour within a province at a given time; where different parts of the same province exhibit marked contemporaneous differences in development at the same time, as appears to be the case in Otago during the gold rush period, nonlinearity of the factor structure may ensue, and the fit of even the unconstrained factor model may not be entirely adequate. Because of limited space, a great deal of statistical fine detail has had to be left out of the discussion. Further, so little archival research has been done on the history of crime and litigation in New Zealand, that we do not have enough external evidence to support the cause and effect relationships we see operating in each province. It is hoped, nonetheless, that our speculations provide a base for others to build on.

In Tables A-III and A-V of Appendix 3 include information on the correlation of factor scores, unconstrained and constrained respectively, with

each of the variables analysed for each province. Generally but not universally these correlations are higher for the unconstrained analysis, since the unconstrained analysis is the better fit for all provinces when 'averaged' over all variables. The importance of these tables is that a high correlation indicates that the factor scores for that province are strongly related to the variable in question in the province concerned, and that a time series plot of the factor scores and the variable concerned would look very similar. High correlations then correspond to variables that are very much like an underlying factor when viewed as a time series plot. Not surprisingly the very highest positive correlations correspond to variables tracking smoothly downward over time, following a peak in the 1870's, rather in the same way as the factor scores. The benefit of these particular correlations is that they allow us to determine that some statistically significant differences between factor loading coefficients (constrained and unconstrained) are spurious. If the correlations with the factor scores, both constrained and unconstrained are low, then although the difference in Table III may be significant, the change of coefficient does not allow the variable to be markedly better fitted in the unconstrained modell, i.e. although the difference is statistically significant, it has little practical effect on an understanding of the structure of the underlying factor when constrained and unconstrained analyses are compared. Care should be taken not to confuse these correlations, which are correlations between rate variables and factor scores, with the covariances between rate variables which are the raw data for the factor analyses.

A final check on the tentative explanations of the underlying history of each province, which follow in the next section, are the time series plots themselves both for the particular variable and also for its appropriately scaled factor scores. These allow us to look more closely at those variables for which the differences in factor loadings between constrained and unconstrained are significant and for which correlations with factor scores are appropriately high.

IV

To summarise our major findings: The statistical analyses of the previous section have allowed us to identify a single underlying factor, which we have named 'atomism', in every one of the nine New Zealand provinces. There are no other factors in the New Zealand data. There is however some variation in the structure of atomism across provinces; these structural differences are not sufficiently marked to indicate that at least one province is fundamentally distinct, but rather indicate that at least one province is a sub-type variant on a global structure.

At the finer level of particular variations, province by province, we are more tentative. What we are able to do is to consider the pattern of differences between the best factor model for each province (the unconstrained model) and the fit of the global factor model for the same data (the constrained model). These differences are summarised in Table III, which lists all the differences in factor loadings, unconstrained less constrained.

To ease the way into the historical discussion, we will begin by offering some preliminary comments on the patterns running across the variables in Table III. We refer only to the statistically significant differences in the factor loadings which are inscribed in bold type in the Table. Factor analytic techniques have been used to define precisely what we mean by differences in kind and differences in degree between provinces: differences of kind are indicated by significant differences in factor loading matrices of the two factor models fitted to each province.

In essence, any significant difference between the unconstrained and the constrained factor loading coefficients for a variable measures the extent to which the part played by the variable in the structure of a province differs from the part the variable plays in the global model. Hence where a positive difference in coefficient is denoted for a variable in a province, this means that, in terms of factor loadings, the coefficient for the variable makes up a larger part of the structure of that particular province than it does in the structure of the nine provinces combined. We might claim that the variable in question (relative to the province's other variables) contributes more to the history of the province than it contributes to the history of all the provinces combined (vis-a-vis all their other variables). Putting this in another way, a positive difference for a province indicates that compared to the global model, the variable is in some way overrepresented in the structure of that province. By the standards of the global model, the variable occupies an abnormally large area of the province's ecology, its function in the provincial environment is stronger than expected. In some contexts, to convey the most appropriate image, we will also say that the variable is comparatively overpowered, even though this phrase is idiosyncratic in a strict statistical sense. By contrast, a negative difference indicates that the variable makes up a smaller part of the province's structure than it does in the global structure. To put this another way, by the standard of the global norm, the variable forms an unusually small area of the structure; in relation to the global model, its contribution to the history of the province is less than expected. As shorthand for all this, we will also talk about the variable as being abnormally recessive, underrepresented in the structure, comparatively underpowered and so on. Although our definitions in themselves do not necessarily extend to interpreting 'predominant' to mean at a higher level than expected, and 'recessive' to mean at a lower, we will indicate explicitly when definition is at

variance with such common usage; the inherent problem that a difference in factor loading coefficients may have a number of possible interpretations, has been discussed in the previous section and the interpretations given below have been subjected to those provisos.

We begin by considering general conclusions based on patterns for coefficient differences for particular variables considered over all nine provinces. We then consider patterns in the exceptional variables for different provinces.

The first general feature of Table III is that the four disorders are rarely listed as aberrant variables (given in bold type). Even so, drunkenness rate (listed four times as significantly different or abnormal) appears more often than violence rate (listed twice) and spirits and civil suits rates (once each). Likewise, coefficients for the three main social deficiency variables are not often inscribed in bold type; percentage of overseas born (or rather the difference in its unconstrained and constrained factor loading coefficients) is significantly abnormal only in two provinces, the ratio of men to women in three provinces, and the ratio of small to total dwellings in just one province. There are also few significant abnormalities in the coefficient differences for percentage of Irish born, percentage of men aged 21-40, and (surprisingly) policing rates. In addition, the Table tells us that immigration rate did not play a significantly different role in any of the nine provinces while emigration rate did so in most of the provinces (with the minus sign, indicating that it played a significantly lesser role in the provinces concerned than it did in the global model). Small dwellings per capita is displayed in bold type only once by contrast with total dwellings per capita which is displayed six times (where usually compared with the global norm it made up an abnormally small part of the structure in those provinces). Two coefficient differences - percentages of adult males and adult females - seem to have performed a significantly aberrant role in a good many provinces (being comparatively underepresented more often than not). As against that, the significant differences for the beer consumption rate coefficients are consistently positive in five provinces, a fact that signifies that beer consumption plays a smaller part in the structure or history of these provinces than it does in the history of all provinces combined. Manufacturing horse-power per capita and percentage of manufacturing employees make a fairly small number of appearances in bold type with a mixture of positive and negative signs. Compared to the global model, the percentage of the urban population is significantly underrepresented in three provinces and overrepresented in another. Finally, imports per capita is listed in bold type fairly frequently while exports per capita is listed very frequently, most of the differences for both sets of coefficients being negative (i.e. the variable plays a lesser role in the ecologies of these provinces than it does in the global model).

Which provinces were exceptional? The results of Table III indicate that every province must have been exceptional, for every province has aberrant coefficient differences. No province, in other words, was exactly the same as the global model and none had a structure which differed in degree only from the global structure. This leaves two possibilities for each province - either it was fundamentally distinctive or it belonged to a global sub-type. We will examine the first of these possibilities towards the end of the paper, and proceed for the moment on the assumption that every province should at the very least be categorised in the global sub-type class. Unless otherwise stipulated, the discussion of each province will only focus upon those variables denoted in bold type in Table III that have a linear relationship (1853-1930) with the general trend taken by all its variables (the unconstrained factor score). For convenience, the provinces have been divided into three groups.

In the first of the three groups of provinces are Hawkes Bay, Taranaki, and Westland. What they have in common is the fact that none of their disorder or social deficiency variables plays a significantly larger part in their respective unconstrained factor matrices than it does in their respective constained factor matrices.

Hawkes Bay, indeed, goes a little further than this, for none of its social deficiency and disorder variables are aberrant in any way. Five other variables, however, are significantly different: percentage of adult females, total dwellings per capita, exports per capita, and emigration rates are underrepresented in the variable structure, while the rate of beer consumption is overrepresented. Of the five, emigration rate is the only one which has a poor correlation with the unconstrained factor score. The best we can do to explain all this is to say that Hawkes Bay was a very settled society. Time series plots show that it had static or very slowly changing yearly percentages or rates of most variables. Its social stability owed much the fact that its early history was rarely punctuated by sudden and short-lived explosions of economic activity. When this occurred in other provinces (often because of the discovery of gold) it always fuelled an equally explosive growth of immigration and of settlement in new areas - the pre-conditions of social atomism. Hawkes Bay's pastoral economy surged three times but not as violently as the economies of, say, the goldmining provinces. On each occasion, interestingly enough, its pastoral frontier moved rapidly into new areas, its export rate and its small dwellings indicator rose sharply along with the rates of violence convictions, drunkenness convictions and civil suits. We suspect that the reason its consumption rate for beer is higher than expected, is related to the fact that its percentage of adult women is unusually small. As colonial women generally drank very little beer, then Hawkes Bay contained an abnormally small proportion of people in the demographic sub-group who generally drank

little or no beer. The cohesive state of the society, however, may have prevented the larger than expected consumption of beer from generating a larger than expected rate of drunkenness and violence convictions.

With Taranaki, all except one of its social deficiency and disorder variables play the same role in its ecology as they do in the global ecology. The exception is spirits consumption rate which is underrepresented. Although this has a low correlation with the unconstrained factor score, it is important to note that the time series plots show that Taranaki's consumption of spirits was negligible. It was also the lowest of all the provinces (see Table I). Rates or percentages of adult males, adult females, total dwellings, imports, emigration and exports (especially) are also underrepresented - but only adult females and exports have reasonably strong correlations with the unconstrained factor score. To put all this in historical context, Taranaki was one of the smallest provinces, and was the poorest and least economically developed during the 19th century. (28) Amongst the causes of its stagnation was its thick forest cover, war between the British and Maoris during the 1860s, Maori disturbances in the 1870s, and the absence of a staple export commodity which made it dependent on subsistence agriculture until the 1890s. The gross underrepresentation of exports in the structure explains why the consumption of spirits per capita was negligible - in a largely subsistence economy, men lacked the cash to buy hard liquor. It is possible that the lower than expected weighting of adult females in the structure may have offset the effect of this somewhat since colonial women drank very little spirits.

Of the nine provinces, Westland was the most disorderly and tended to have the highest social deficiency variables (see Tables I and II). Yet it is intriguing to note that none of the social deficiency variables is aberrant. And every one of the disorder variables is very close to the global norm except drunkenness rate and this is significantly below the norm. Only two other variables are aberrant - percentage of adult females and total dwellings per capita (both being overrepresented in the structure). Although the correlation of drunkenness rate with the unconstrained factor is poor, this in itself is very revealing. We drew attention previously to the fact that of the four disorder variables, the rate of drunkenness convictions occurs most frequently in bold type in Table III. Yet spirits consumption rate - which theoretically was the most likely immediate cause of actual drunkenness - appears only once. The discrepancy is very strong evidence that the rate of drunkenness convictions was sensitive to variations in control responses. What tends to confirm this is that in all the provinces where drunkenness rate is aberrant, spirits consumption rate is not aberrant. With these provinces it is likely that official reactions and public attitudes towards behaviour associated with drunkenness distorted the generation of the statistics for drunkenness convictions to a much greater extent than

was the case in New Zealand as a whole. Returning to the particular example of Westland, we find that, compared to the global model, its drunkenness convictions are unusually low in relation to its level of spirits consumption. Table III indicates that neither its beer consumption rate nor its police numbers per capita is significantly different in any way. This leaves the possibility that the police and public opinion in Westland were peculiarly tolerant of excessive drinking. Although we have no means of confirming this hypothesis directly, it does fit several facts. One is the modern New Zealand legend that the police in Westland, unlike the police in other parts of the country, have always turned a blind eye towards the violation of New Zealand's stringent licensing laws. The other is its peculiar history. (29) In contrast to all the other provinces, it was solely the discovery of gold which led to its colonisation in the mid-1860s; it was populated during this formative stage by a horde of unruly miners from California and Australia; it received relatively few immigrants thereafter; and it has always been very isolated from other parts of the country. Given these circumstances, it seems logical to believe that public opinion in Westland developed particular notions of what constituted excessive drinking which the authorities had to accept. We doubt that the total dwellings and adult females variables add much to this explanation.

Then there are four provinces - Canterbury, Wellington, Auckland, and Otago - in which the social deficiency variables generally had less capacity to drive the disorder variables than they did in the global model.

What puts Canterbury in this group is that all its disorder variables are on about the same level as those in the global structure yet one of its social deficiency variables - the ratio of men to women - is at a significantly lower level than its counterpart in the global structure. This implies that the dominant mechanism in Canterbury (social deficiency) was relatively underpowered. Hence, even though the place of the disorder variables was little different in both models, the dominant mechanism was comparatively weaker in Canterbury's. Some secondary cause, therefore, must have been more powerful in the Canterbury causal structure than it was in the global causal structure in order to push along Canterbury's disorders. Table III suggests that there were seven possible candidates. After we exclude those which have poor correlations with the unconstrained factor score, we are left with three: the percentage of urban dwellers (under-represented in the structure), beer consumption rate (over-represented), and small dwellings per capita (under-represented). Time-series plots show that these aberrations prevailed up to the 1870s but died out thereafter. According to our interpretation of this pattern, Canterbury early in the period had a higher than expected percentage of rural dwellers which acted as an unusually large secondary cause of the disorders (and of beer consumption). These rural dwellers were basically located on the pastoralist frontier whe-

re settlement was new and particularly thin and where as a consequence informal community controls were extraordinarily weak. The effect, however, of this secondary mechanism on the three disorder variables and beer consumption was offset to some extent by Canterbury's relatively small proportion of small dwellings per capita. In the other provinces where small dwellings per capita were significantly lower than the global norm they tended to increase the disorder risk.

With Wellington, violence rate is unusually overpowered and the overseas born rate is underpowered. They have strong correlations with the unconstrained factor score as do five other aberrant variables: the rates or percentages of urban population, adult females, beer consumption, manufacturing employees, and emigration. The interpretation for this is relatively simple. First, if it is assumed that high rates of emigation in colonial New Zealand acted as a safety valve, removing from a province its most footloose and disorder-prone men, then it follows that Wellington's grossly underloaded emigration rate to 1896 reduced the effectiveness of the safety valve. Second, if it is agreed with Roger Lane that the routines and disciplines of factory life curb impulsive behaviour, it can be inferred that the abnormally small part factory life played in Wellington increased the chances of impulsive violence. (30) Third, since urbanism and adult females were associated with a low disorder risk, it follows that by forming an abnormally small part of the Wellington structure (at least for a period), they pushed up violence rate to a higher level than expected. (31) Last, since beer consumption rate (given all the other variables) was higher in Wellington than in all the provinces (given all their other variables), and since alcohol has a strong causal link with violence, it makes sense to say that violence rate was usually high in Wellington because the rate of beer consumption was as well. (32) In other words, Wellington's secondary causes of violence were more powerful than the same secondary causes in the global model, and this compensated for the lower than expected percentage of overseas born in the dominant mechanism.

Auckland's aberrant variables form a more complex picture. As none of the social deficiency variables are lower than expected and as drunkenness rate is higher than expected, this makes Auckland exceptional according to our definition. (33) The complication, however, is that the rate of civil suits is lower than expected. Thus we have to find the secondary mechanisms which not only explain why the drunkenness rate was unusually high but also why the rate of civil suits was unusually low. Of the nine other aberrant variables, seven have strong correlations with the unconstrained factor score, namely the rates or percentages of Irish-born, urban dwellers, adult females, manufacturing horse power and manufacturing employees, imports and exports. One explanation for the drunkenness rate may be demographic. Table III indicates that the percentage of

adult females is abnormally small; in colonial New Zealand as in other societies women had far less freedom to drink excessively than men; therefore the rate of drunkenness was peculiarly high (given all the other variables) since Auckland contained an abnormally small proportion of people in a demographic sub-group who had little freedom to drink to excess. But this is difficult to reconcile with the fact that neither spirits nor beer consumption rates are overrepresented in the Auckland structure. Instead what seems to have generated abnormally high rates of drunkenness convictions is that the Irish born were the targets of police and judicial discrimination. Supporting this possibility is that the percentage of Irish born (but not spirits or beer consumption rates) is overrepresented in the Auckland model. Supporting it too is that Auckland's Catholic Irish population were forced to take sides in an extraordinarily bitter political struggle which split the Auckland elite during the 1840s and 1850s - a power struggle that was without parallel in New Zealand history. (34) Harder to account for is Auckland's abnormally low rate of civil suits, since this variable has a poor correlation with the unconstrained factor score. However, the time series plot for civil suits in every province shows that over the nineteenth century Auckland had lower and generally less volatile rates of civil suits than the other provinces but that the rates rose after 1903 until by 1930 they were the highest in New Zealand. Corresponding with these trends is Auckland's economic development which was fairly weak over the nineteenth century but 'took off after the turn of the century when the province became the centre of New Zealand's rising dairying industry. (35) The growth of manufacturing horse power per capita is especially sharp from 1900 to 1930 (it increased seven fold). Richard Kagan in his study of litigation in sixteenth century Castile has argued that a rise in the volume of commercial transactions naturally increased the incidence of civil suits simply by expanding the number of transactions which were inherently disputable. (36) The same mechanism may have operated in Auckland to a greater extent than elsewhere in New Zealand. On top of this, the virtual disappearance of the very small group of leading businessmen living in Auckland City, following a financial crisis in the late 1880's, and their replacement by new entrepreneurs after 1900 may have changed the mediation culture; the pre-1890 business class was small, long-established and strongly interconnected and thus may have settled their conflicts informally whereas the newcomers after 1900 were more numerous and less cohesive and so may have had little option but to resort to court action more frequently. (37)

The last province in the second group is Otago. It fits this category since all its social deficiency variables are at about the same level as they are in the global environment (relative to all the other variables) while the drunkenness rate is significantly below. Unfortunately, the two other aberrant

variables (total dwellings per capita and percentage of Irish born) do not explain why the drunkenness rate is overrepresented. Total dwellings per capita have a poor correlation with the unconstrained factor score. Although the percentage of Irish born has a good correlation, Table III indicates that the variable was significantly negative, implying that the proportion of Irish born played a less important role in Otago's history (in relation to all the other variables) than it did in the history of all the provinces combined (relative to their other variables). This leaves us with only two other possible explanation for drunkenness rates. One is that over the long term the police, the courts and the public took a particularly hard line against drinking or behaviour labelled as drunkenness than they did in New Zealand as a whole. Although the hypothesis is inherently plausible (the spirits and beer consumption rates are not aberrant) we do not know why the control response in Otago was different. The other possibility is that we have not selected the right variables to explain what was happening to drunkenness. What tends to bear this out is Table A-I of Appendix 3 which shows that Otago comes out as the worst province on a statistical test measuring how well each unconstrained factor fits all the variables in each province.

Two provinces - Marlborough and Nelson - form the third group. With these provinces it is difficult to tell whether the social deficiency variables had less power to drive the disorders than they did in the global model. What makes Nelson ambiguous in this respect is that two of its disorder variables (drunkenness and violence rates) are abnormally large and one of its social deficiency variables (the ratio of adult males to females) is as well. Looking at the other aberrant variables, we find that five have strong correlations with the unconstrained factor score: percentage of men aged 21 to 40, beer consumption rate, police numbers per capita, imports per capita, and emigration rate. Since the rate of emigration was negligible over the whole period, it is most unlikely that this had anything to do with violence and drunkenness rates. Nor do we see any significance in imports; in Nelson's case there is every reason to believe that it is a very unreliable measure of prosperity. (38) However, it is almost certain that the higher than expected rate of consumption of beer was a cause of the higher than expected level of the violence and drunkenness rates. And the same can be said for the abnormal number of police per capita ('more police detect more crimes') and for the abnormal proportion of young adult males ('more young men mean more law breaking'). (39)

Marlborough is even more ambiguous. Table III indicates that none of its disorder variables is abnormally high. But it also suggests that one of the social deficiency variables (percentage of overseas born) is underpowered while the two others are overpowered. Our methods of analysing and classifying the statistical structures of the provinces do not allow us to

determine whether on balance the dominant mechanism in the province had the same capacity to drive the disorder variables as it did in the global model. What adds to the complexity is that two secondary mechanisms in the causal structure seem to be working in opposing directions. One such mechanism consists of the proportion of adult females, proportion of men aged 21-40, and the beer consumption rate. According to Table III, the percentage of adult females played a smaller than expected role in Marlborough's history, while percentage of men aged 21-40 and beer consumption rate played a larger than expected role. (40) What this suggests is that in relation to all its other variables, the province had fewer women per capita, a greater surplus of young adult males per capita, and therefore drank more beer per capita than the other provinces. These variables have strong correlations with the unconstrained factor score. (Note that the list of aberrant variables also includes emigration rate, total dwellings per capita, and manufacturing employees per capita, all of which correlate poorly.) The other, opposing, mechanism consists of the forces of cohesion. Throughout the period, the land-use in the province was dominated by very large scale sheep farming (ranching) which first began in the 1850s. In addition, it experienced no speculative booms and although affected by gold rushes in the 1860s these were minor, shortlived, and confined to a tiny coastal fringe of the province. As a consequence, after the early 1870s the province grew very slowly indeed and was affected by very little social, demographic and economic change - which is partly reflected in the fact that over the whole period it had the smallest population of all nine provinces. Its social deficiency variables also tended to fluctuate less during the frontier period from the 1850s to the 1860s compared with other provinces, and started their long-term declines from an earlier point. Interestingly enough, the disorder variables (apart from civil suits rate) conform to the same pattern. It is tempting to conclude that the reason that the disorder variables were not aberrant is that these forces of cohesion plus the unusually low strength of one part of the dominant mechanism countered the two parts that were overrepresented.

So far the results of our statistical analysis have shown that the ecology of petty violence convictions, civil suits, drunkenness convictions and spirits drinking in every province had abnormal elements and that in no two provinces were these abnormal elements the same. Indeed the abnormalities in causal structure were so variable and idiosyncratic that it is very difficult to formulate a theory which can explain the overall pattern of abnormalities. If there is any lesson which can be drawn from all of this it is that even in a simple and small frontier society like New Zealand the hierarchy of causes responsible for interpersonal conflict and excessive drinking was highly unstable - in one setting or region the relative position of the causes in the hierarchy had an overwhelming tendency to differ

substantially from their rank order in the hierarchy of another setting or region. In this place the standard of living was an abnormally powerful cause, in that place factory life was further up the hierarchy than in all places combined, in another place urbanization was lower down the hierarchy, and so on. This finding leads to another question: given that the relativities between the variables differed substantially from province to province, is it also likely that in some provinces the whole structure itself differed fundamentally from the global type? To answer the question we applied a series of four tests to the data, and it is noteworthy that all these tests show that the ecology of every single province was basically similiar to the global type. In other words, although one of our conclusions is that each province was exceptional, we also find that there were important limits to the extent to which each deviated from the global model. Putting this another way, our tests imply that each province should be classified as a global sub-type but not as a fundamentally distinctive type. In the first place, despite significant differences between provinces in factor loading matrices, a comparison of the constrained with the unconstrained factor loading matrix for each province reveals that the factor loading coefficients for a given variable are almost universally of the same sign, and that those exceptions that there are, are usually associated with small factor loadings. This indicates that, although not identical, constrained and unconstrained models are inherently similiar. In the second place, if factor scores from different provinces are intercorrelated, correlation coefficients are very high, all more than 0.95 for the constrained model and more than 0.90 for the unconstrained model. This indicates that the single factor, 'atomism', is much the most marked effect for every province. Thirdly, all constrained and unconstrained factor models, eighteen in all, are one factor models. This indicates that even the global or constrained model has considerable power to explain the relationship between rate variables in the analysis. Lastly a comparison of time-series plots for each province indicates that nearly all the disorder and social deficiency variables in the nine provinces went through the same long-term trends, that is, they fluctuated strongly around their highest historical levels before the 1880s and then declined markedly and almost monotonically until the end of the period. All the evidence, in other words, demonstrates that much the strongest effect in the New Zealand provincial data, an effect which seems to be an order of magnitude stronger than any other general effects, is the factor we have called 'atomism'.

That 'atomism' dominated the structure of each of New Zealand's nine provinces is attributable to two things. One is that early in their history all the provinces went through a spasm of colonization which stimulated very high rates of immigration and that pushed most immigrants into new territories where community ties and informal restraints were temporarily

very weak. The other is the relative homogeneity of New Zealand society - none of the provinces contained gross peculiarities capable of producing a factor or factors additional to 'atomism'. In this connection, it should be noted that some of the conditions that might be expected to produce fundamental exceptions did not do so. These conditions include armed conflict between indigenous peoples and white settlers (this affected some provinces but not others in the 1860s); marked disparities between provinces in the level of the social development (this does not affect our model); economic backwardness (the example of Taranaki has already been cited); and a high level of economic inequality (this characterised the pastoral provinces).

Let us end by speculating about the implications of this study for other frontier societies. It is probable that they too went through an early phase of social deficiency arising from very high rates of immigration and territorial expansion (except perhaps for those societies where labour was unfree and the incidence of chain and group immigration were particularly high). But it is also likely that few frontier societies were as spatially homogenous as New Zealand given, for instance, that most tended to be much larger in scale, their histories were longer, they had more territorial sub-divisions, they contained larger cultural minorities, their formal institutions of control were more likely to be decentralised, they had at least a few regions which developed in extreme isolation and so forth. For this reason we would expect that the role of 'atomism' in many of the regions of, say, Australia, Canada and the American west would have been supplemented or dampened by factors which were absent in New Zealand. Even so, we would conjecture that our 'atomism' model represents, to a fair degree, a universal bedrock for frontier societies, were we able to strip away their complexities and idiosyncracies.

Notes

(1) See e.g. D. Denoon, Settler Capitalism: the Dynamics of Dependent Economic Development in the Southern Hemisphere, Oxford, 1983.

(2) M. Fairburn and S.J. Haslett, Violent Crime in Old and New Societies - a Case Study based on New Zealand 1853-1940', Journal of Social History, Fall 1986, 89-126.

Some insight into the character of the violence and civil suits cases comes from five detailed studies of local courts in the early part of the period - but it must be emphasised that it is not known if these cases were typical everywhere over the whole period. An infinitessimal portion of the civil suits were vexatious, settled out of court or involved defamation. Most were brought to recover bad debts (owing to shop-

keepers, tradesmen, landlords); nearly all the rest for damages over breaches of contract (usually price or performance) and failure to pay wages. A disproportionate number of the plaintiffs were businessmen and the settled (shopkeepers, tradesmen, hoteliers), while the defendants tended to be disproportionately manual workers (including miners in mining districts) and transients. Interestingly enough, although most assault cases appear to have been precipitated by drunken quarrels, a large minority involved the same issues as the civil suits and the same individuals. More interesting still, there was no class bias in the composition of the cases: the proportion of middle class victims was not significantly different from the proportion of middle class assailants, and the same is true of manual workers and transients. Transients are defined as those who were not listed in the street directories nor in the electoral rolls. A more detailed discussion of these five local case-studies is in M. Fairburn, The Ideal Society and its Enemies; The Foundations of Modern New Zealand Society, Auckland, 1989. One local study was of a Westland court; all the others were of courts in Wellington province.

Female crimes were disaggregated from male crimes in the yearly Justice Statistics from 1872 onwards. In the early 1870s the rates of summary drunkenness convictions for males were 3.5 times higher than the female rates. The male rates of summary convictions for offences against the person were 4 .6 times higher than the female rates. By the 1930s the differences had widened sharply. The male drunkenness rate was 18.3 times greater than the female and the male violence rate was 17.7 times the female one. The rates are calculated using adult males and adult females as the population base. The difference between the rates of civil suits for men and women is not known for the Justice Statistics never separated them out.

(3) Most cross-sectional studies pool or compare data taken from a few selected regions or localities of a society. Often these studies attempt to test particular theories of crime by classifying the localities/regions by ecological type, with some of the places acting as proxies for the theories and some acting as controls. The data in most instances are drawn from all surviving files on actual cases deposited by local courts. Examples of such studies include J. A. Sharpe, Crime in Seventeenth-Century England, Cambridge, 1983, esp. ch. 11; J. M. Beattie, The Pattern of Crime in England 1660-1800', Past and Present, 62, Feb. 1974, 47-95; J.M. Beattie, Crime and the Courts in England, 1660-1800, Princeton, 1986; B. Hanawalt, Crime and Conflict in English Communities, 1300-1348, Cambridge, Mass. 1979; J. B. Given, Society and Homicide in Thirteenth Century, Stanford, 1977; D. Philips, Crime and Authority in Victorian England: the Black Country

1835-1860, 1977; D. H. Flaherty, 'Crime and Social Control in Provincial Massachusetts', The Historical Journal, 24, 1981, 339-59; I. A. Cameron, Crime and Repression in the Avergne and the Guyenne, 1720-1790, Cambridge, 1981.

Less common are the mass quantitative studies which apply multivariate analysis to all the major administrative regions of an entire society. These test theories by determining the statistical relationship across all the places between a crime indicator (or indicators) and a selection of variables, each of which is a proxy for a particular theory. Examples of this approach include D. Cohen and E.A. Johnson, 'French Criminality: Urban-Rural Differences in the Nineteenth Century', Journal of Interdisciplinary History, xii, Winter 1982, 477-501; E.A. Johnson, »The Roots of Crime in Imperial Germany', Central European History, v, Dec. 1982, 351-76; A. Q. Lodhi and C. Tilly, 'Urbanisation, Crime and Collective Violence in 19th century France', American Journal of Sociology, lxix, July 1973-May 1974, 196-218; V.E. McHale and E.A. Johnson, 'Urbanization, Industrialization, and Crime in Imperial Germany: Parts I and 2', Social Science History, Fall 1976, and Winter 1977, 45-78, 210-47; H. Zehr, Crime and the Development of Modern Society - Patterns of Criminality in Nineteenth Century Germany and France, London, 1976; A.R. Gillis, 'Crime and State Surveillance in Nineteenth-Century France', American Journal of Sociology, 95, Sept. 1989, 307-41.

The major multivariate technique we apply is factor analysis: two different factor analyses are applied to each province; in the first the same factor structure is applied to all provinces, in the second each province is fitted by its own factor structure.

(4) General histories of New Zealand covering these defining characteristics include Fairburn, The Ideal Society and its Enemies ; G.R. Hawke, The Making of New Zealand; an Economic History, Cambridge, 1985; R.M. Burdon, The New Dominion, Wellington, 1965; J.B. Condliffe, New Zealand in the Making, London, 1959; J.B. Condliffe, The Welfare State in New Zealand, London, 1959; W.H. Oliver (ed.), The Oxford History of New Zealand, Oxford and Wellington, 1981; W.B. Sutch, The Quest for Security in New Zealand 1840- 1966, Wellington, 1966; K. Sinclair, A History of New Zealand, rev. ed., London, 1980; A. Siegfried, Democracy in New Zealand, London, 1914. Studies of the history of crime, its social context and the courts in New Zealand are in their infancy; a selective overview of the latest research is in C. Macdonald, 'Crime and Punishment in New Zealand, 1840-1913: a Gendered History', New Zealand Journal of History, xxiii, April 1989, 5-21.

(5) The evidence that the ratio of small to total dwellings in New Zealand measures not poverty but social deficiency is discussed by Fairburn and Haslett, Violent Crime and Old and New Societies'.

In forming our list of the three most important variables, we began by eliminating variables that yielded low or negligible values when intercorrelated with the four disorder variables. The discarded variables included the percentage of Maori in the population, immigration per 100,000 population, emigration per 100,000 population, the total number of dwellings per capita, the proportion of people who were urbanised, the level of living standards (import values per capita), total dwellings per capita, the degree of economic development (export values per capita), the annual population growth rate, manufacturing employees and horse-power per capita, and annual growth and change rates of virtually every variable. Next, we went through the variables which intercorrelated moderately with the disorder syndrome and argued that although each may have played a part in the mechanism it was a minor one. Variables in this category were police manpower per capita, the percentage of men aged 21-40, the proportion of the Irish-born in the population, and beer consumption (gallons per capita).

(6) See e.g. J.A. Sharpe, 'Enforcing the Law in the Seventeenth-Century English Village', in V.A.C. Gatrell, B. Lenman, G. Parker (eds), Crime and the Law: the Social History of Crime in Western Europe since 1500, London, 1980; Given, Society and Homicide; M.J. Ingram, 'Communities and Courts in Early-Seventeenth-Century Wiltshire', in J.S. Cockburn (ed.), Crime in England 1550-1800, London, 1977; J.M. Beattie, The Criminality of Women in Eighteenth Century England', Journal of Social History, vol. 8, Summer 1975.

(7) N. Elias, The Civilising Process: the History of Manners, New York, 1978.

(8) Flaherty, 'Crime and Social Control'.

(9) The complete list of variables considered in the present analysis is given in Appendix 1.

It is not necessary for the decline in 'atomism' to be contemporaneous in different provinces for validity of a global model, given provincial level data; if national figures only were available in each year and changes were not contemporaneous, then a national model is likely to be misleading since it would amalgamate information from parts at different stages of development. The timing of development in New Zealand is remarkably parallel across provinces, and in any case our studies do not use aggregated national statistics.

(10) The stress on interprovincial and regional differences is implicit in most of the literature on 19th century New Zealand. It has been explicitly advocated by W.H. Oliver, Towards a New History?, Hocken Lecture 1969, University of Otago; R.C.J. Stone, 'Clio and the Parish Pump; Recent Books on New Zealand Local History', New Zealand Journal of History, vii, April 1973; W.J. Gardner, 'New Zealand Re-

gional History and its Place in the Schools', New Zealand Journal of History, xiii, Oct. 1979; W.J. Gardner, 'New Zealand Regional History: General and Canterbury Perspectives', Historical News, 41, Oct. 1980. The development of the paradigm was strongly influenced by the trend that arose in international historiography during the 1960s and 1970s which emphasised the regional and local heterogeneity and autonomy of the pre-modern world.

(11) See D.H. Akenson, 'Immigration and Ethnicity in New Zealand and the USA - the Irish Example', in J.O.C. Phillips (ed.), New Worlds? The Comparative History of New Zealand and the United States, Stout Research Centre, Wellington, 1989.

(12) R. Hill, Policing the Colonial Frontier: the Theory and Practice of Coercive Social Control in New Zealand 1767-1867, Wellington, 1986; and The Colonial Frontier Tamed; New Zealand Policing in Transition, 1867-1886, Wellington, 1989. A third and fourth volume in this series will take policing history up to the 1980s. Complicating the picture of provincial policing, 1853-1876, was the operation of the Armed Constabulary, established in 1867. Placed under the jurisdiction of the central government, the AC supplanted the police force in Auckland province, but operated independently of the police regimes in several other North Island provinces where its only function was to repress Maori insurrections. The history of the courts remains unwritten.

(13) The methods used were governed, as in our 1986 paper, by the destruction of nearly all police files on offenders, the poverty of detail in the few surviving court calendars, and the lack of contemporary discussion on criminality. The reason we have used a probability-based methodology is quite simple. The only alternative to it would have been to engage in micro-methodology - to examine all the surviving court records held in archives for every civil suit, drunkenness case, and violence case that went through every local court over the whole 1853-1930 period. Such an exercise would have been physically impossible. Apart from the fact that there are large gaps in the archival sources, the volume of cases which flowed through the courts was colossal. In 1930 alone New Zealand's magistrates tried 63,120 civil cases, convicted 578 people for minor violent crimes, and convicted 6,072 people for drunkenness. The rates of violent crime were statistically related to a range of other indices of social, demographic and economic activity. Other variables were selected to test a variety of alternative explanations, the principal constraints being availability and reliability of the raw data.

(14) For further details on statistical techniques appropriate for analysis of historical data see Appendix 3 of S.J. Haslett, and M.F. Fairburn,

Differences in the Rates of Minor Crimes of Violence and Related Disorders in Nine New Zealand Provinces, 1853-1930. Institute of Statistics and Operations Research Technical Report, Victoria University of Wellington, New Zealand, July 1990.

Details of the way in which measurement error affects factor analysis can be found in Appendix 2A. Measurement error is the technical term encapsulating questions about the reliability and intrinsic meaning of some variables used in analysis. In our case, such errors are most pronounced for import, export, immigration, and emigration rates, where the provincial raw data are of questionable reliability. It is not known how much of the imports and how many of the immigrants recorded as entering a particular province from outside New Zealand were actually destined for another province; similiarly it is not known whether some of the exports and emigrants registered as leaving any given province in reality came from other provinces. It is conceivable that these data are overstated for the major provinces (Auckland, Wellington, Canterbury and Otago) which contained New Zealand's principal overseas ports, and understated for the other provinces where the ports played a minor part in the movement of goods and people to and from the country.

(15) For the list of variables used in the present paper see Appendix 1. All nine provinces were analysed separately with a maximum of 78 years of data 1853-1930 for each province. Extensive exploratory data analysis was undertaken; all possible pairs of variables were plotted as scatterplots marked both by provincial district and year. Where possible, missing data were interpolated before calculation of rate variables. Reliance on census sources for some of the data provided most of the missing values. There were fourteen censuses between 1858 and 1930; when data were missing on any variable, they were estimated using linear interpolation between census years. Fortunately, a minute difference exists between correlations based solely on census year points and those based on the data incorporating the interpolations of the provinces as units of measurement. The variable for the number of Maoris per capita was dropped since the rates of Maori civil suits, drunkenness convictions and violence convictions were extremely small in relation to the European. Differences between rates in successive years and rates of yearly change between successive years proved to have either very small or very large correlations with each other and with the rate variables; they were consequently dropped from the factor analyses. Whether such variables are in fact related to some underlying factor can not be decided from these results; the problem may be one of statistical power in the presence of the large measurement errors that result from differencing and determining

rates of change for variables already subject to measurement error; such estimates were particularly unstable for the earlier years and it was the earlier years which by providing the extreme values largely determined the estimated correlations between variables.

It should also be noted that New Zealand in fact had 10 provinces. The one we did not treat separately was Southland. As it was part of Otago for a large part of the 1853-1876 period, and as it was surrounded by Otago, we integrated the data set for Southland into the Otago data set.

(16) See, for example, Cohen and Johnson Trench Criminality'; Fairburn and Haslett 'Violent Crime in Old and New Societies'; Zehr, Crime and the Development of Modern Society .

(17) The number of small dwellings per 100,000 of population, the total number of dwellings per 100,000 of population, and the ratio of small to total dwellings form one such group. This device is not a complete answer to the problem of fitting nonlinear models however; it provides a first approximation. Given that no model is likely to be a perfect description of the underlying reality, what we are attempting to do here, by incorporating similar but nonlinearly related variables, is to fit a model which incorporates as much as possible of the available information within the factor analytic framework. Our success or failure to find such a model will be assessed by the extent to which the model explains the variability in the data.

(18) Global means and national means are equivalent, although global and national factor analyses are not.

Because the rate data are not normally distributed, unweighted least squares rather than maximum likelihood was used to fit the factor analyses. Non-normal data has the disadvantage that chi-square statistics are not appropriate for testing model fit; although their statistical properties are largely unknown, L1SREL provides other information, which has been used here, as a guide to adequate model fit. This information includes an adjusted goodness of fit index, for which the maximum possible value is one, together with root mean square residual and a Q-plot of normalised residuals. (See Table A-1). The root mean square residual has the interpretation that it is in some sense the average value of the deviation of the off-diagonal elements of the covariance matrix fed into the factor analysis, from the covariance matrix estimated by the factor analysis; the rescaling of all variables by their global means aids in the interpretation of this statistic since all rate variables are then weighted nearly equally when the root mean square residual is calculated. 'Residual' in this case refers to residuals from the covariance matrix not the original data, so that there are $p(p-1)/2$ such residuals if there are p variables, one residual

for each unique off-diagonal element of the covariance matrix. The Q-plot is a graphical method of representing the all of these covariance residuals by ordering them in magnitude and comparing them with some prespecified standard.

(19) Each factor analysis was carried out using the Version VI of the LISREL software within SPSSX (Statistical Package for the Social Sciences). The rate data are not normally distributed. While it was possible to stabilise variances to some extent by taking logarithms of the rate variables, the results of the analysis were little different; given that using logarithms had only a small technical advantage, the analysis was carried out using the rate variables themselves for ease of interpretation.

(20) Summary statistics assessing the fit of these models for each province are given in Appendix 4 Table A-1. No fitting procedure, whether maximum likelihood, two stage least squares, generalised least squares, instrumental variables, or unweighted least squares would allow LISREL to fit a two factor model to the data for any of the nine provinces or to the global data.

(21) The factor loading matrices for the constrained fits differ between provinces only in scaling factor, so that all elements in any one column are the same scalar multiple of the corresponding elements in any other. Strictly speaking the factor loading matrices tabulated for all the constrained factor models are in fact scaled by an appropriate standard deviation (see Appendix 2B for details) ; for the unconstrained analyses, since each province is fitted independently of all other provinces, these scaling factors have all been set at one without loss of generality.

(22) All unconstrained one factor models seem to give an adequate fit when judged by the various relevant summary statistics, although the model for Otago would seem to indicate significant nonlinearities (see Table AT of Appendix 4).

(23) T.W. Anderson and Y. Amemiya, The Asymptotic Normal Distribution of Estimators in Factor Analysis under General Conditions', The Annals of Statistics, 1988, Vol 16, pp.759-71.

(24) Judging statistically significant differences is based on testing the hypothesis test that two random variables come from the same parent population given their estimated variances. The technique here is essentially the same as testing the difference of two means. (See e.g.M.R. Spiegel, Theory and Problems of Statistics, London, 1972, p. 170, for the method of testing the difference of two means.) The usual convention is to consider effects significant at the 1% or 5% level, but here we have 22 differences per province to test, giving a total of 22*9 = 198 tests. Even at the 1% level we would thus expect two false indicators of

significant differences; significance levels were thus considered in three ranges: less than 0.01%, between 0.01% and 0.05%, and between 0.05% and 0.1%. Even the upper limit of 0.1% corresponds to an expectation of less than 0.2 false conclusions of a significant difference where in fact none exists, taken over the entire 198 tests.

For our data we used the results of Anderson and Ameniya, 'Asymptotic Normal Distribution', pp. 759-71, to estimate the variance of the factor loading coefficients for the unconstrained factor analysis for each province from fitting an unconstrained maximum likelihood model via LISREL. The computer algorithms for maximum likelihood factor analysis are notoriously unstable; it is not always possible to fit a maximum likelihood model even where the data are normally distributed. Where for a given data set, one factor model can be fitted by maximum likelihood and the other not, and where those models contain both the same number of variables and factors, the result that the standard errors of the estimated coefficients are proportional to the square root of the sample size can be used to provide an approximation. See D.N. Lawley and A.E. Maxwell, Factor Analysis as a Statistical Method, London, 2nd ed., 1971, pp. 48-65. If, to a first approximation, the other contributions to the standard error for the two models are assumed equal, the standard error for any element in the factor loading matrix for the model which can not be estimated by maximum likelihood, can be estimated as a scalar times the standard error for the corresponding element in the factor loading matrix in the other model; the scalar is simply the square root of the quotient of the sample size for the model that can be fitted by maximum likelihood, to the sample size for the model that can not. Except where the factor loading coefficients for one model are estimated from some larger data base and then applied to some subset of the data, as here, the two sample sizes would be equal. For the constrained factor analytic model, the maximum likelihood model failed to converge for any of the nine provinces. The variance of the constrained factor for each province was estimated (following Lawley and Maxwell, especially equation (5.29) and Section 5.2) as being 77 / 702 (76 / 702 or 78 / 702 in the case of some provinces) times the average variance across provinces for each element in the constrained factor loading matrix, adjusted by the square of the appropriate rescaling for each provincial constrained factor loading matrix. The factor of 77 / 702 arises from the fact that there are usually 77 observations per province for the unconstrained fit, and 702 taken over all the provinces for the constrained (i.e. global) fit. The approximate equality of the variances for unconstrained and constrained factor loadings for each province, had the sample sizes used in estimation been equal, follows from equation

(5.29) in Lawley and Maxwell, given that unconstrained factor loading coefficients are sub-type variations on a global type. Given variance of the differences in factor loadings, unconstrained less constrained, the statistical significance of the calculated differences can thus be found using a normal approximation.

(25) D.F. Morrison, Multivariate Statistical Methods, 2nd ed., London, 1976 , pp. 334-6.

(26) We have made the point that factor analyses provide factor scores as well as factor loading coefficients. Although intimately related these two ideas should be kept separate. Factor scores in our case indicate how the single underlying factor in each province (whether constrained or unconstrained) is moving over time. Time series plots of factor scores show a general downward trend from the 1870's in most provinces, especially in the case of unconstrained factor scores.

(27) The extent to which 'atomism' is reflected in the variables studied can be measured by their statistical correlation with one another, high magnitude correlations indicating a variable is very like the factor in its behaviour over time, low magnitude correlation indicating factor and variable are only weakly related (see Tables ATI1 and A-V of Appendix 4). Now some of the aberrant variables in each province have only a small statistical association with its unconstrained or constrained factor scores. Since these variables provide a misleading picture of what is going on in each province they need to be weeded out. Unless they include the social deficiency variables they will not be considered in the discussion; the others will be considered only if our scrutiny of supplementary data has indicated that they seem to have exercised some influence on the disorder variables. Subject to these provisions, we have defined the spurious aberrant variables as those which in each province have a correlation with magnitude less than 0.7 with the unconstrained factor score; this level has been chosen because, for a given variable, it corresponds to 50% of the variability being explained.

(28) For the trends in Taranaki's economic development see K. Sinclair and W.F. Mandle, Open Account - a History of the Bank of New South Wales in New Zealand 1861-1961, Wellington, 1961, ch. viii.

(29) For Westland's peculiar history see P.R. May (ed.), Miners and Militants: Politics in Westland 1865-1918, Christchurch, 1975.

(30) Roger Lane, Violent Death in the City; Suicide, Accident and Murder in Nineteenth-Century Philadelphia, Cambridge, Mass., 1979. Note though that in Wellington after 1896 the percentage of manufacturing employees was higher than expected, relative to the global model as measured by the scaled factor score, whereas up to 1896 it was lower than expected.

(31) Percentage of the population that were urban was lower than expected to the mid 1870s, relative to the global model; thereafter it was higher than expected , except briefly. 1890 - 1900. For an explanation of this see M. Fairburn and S. Haslett 'Did Wellington Province from the 1850s to 1930 have a distinctive social pattern?' in D. Hamer and R. Nicholls (ed.), The Making of Wellington 1800-1914, Wellington, 1990, 255-83.

The percentage of adult females went through two change over points, relative to the global model. Before 1866 it was higher than expected, from 1866 to 1898 it was lower than expected, thereafter it was higher than expected.

(32) See e.g. V.A.C. Gatrell and T.B. Hadden, 'Criminal Statistics and their Interpretation', in E.A. Wrigley (ed.), Nineteenth-Century Society: Essays in the Use of Quantitative Methods for the Study of Social Data, Cambridge, 1972.

(33) The drunkenness rate in Auckland, however, goes through a change point in 1876, relative to the global model; before this it was higher than expected, peaking in 1871; thereafter it was lower than expected.

(34) R. Stone, 'Auckland Party Politics in the Early Years of the Provincial System, 1853-58', New Zealand Journal of History, 14, Oct. 1980. The percentage of Irish born has a change over point in 1891; before then it was higher than expected relative to the global model, thereafter it was lower. But also note that in the late 1860s a sharp increase in drunkenness rate corresponded with a sharp rise in the percentage of adult males and the adult male to female ratio; during this period the percentage of Irish born remained constant, suggesting that it was the arrival of adult males in Auckland that contributed to the drunkenness figures rather than the Irish per se.

(35) The weakness of Auckland's economic development before the turn of the century is discussed in R. Stone, Makers of Fortune - a Colonial Business Community and its Fall, Auckland, 1973, chs ii and iii. Stone's thesis is that although Auckland's economy grew before the 1880s, a significant amount of the growth (especially during the 1870s) was artificial and ephemeral since it was based on speculative investment which had little chance of yielding a sustainable return.

(36) R. Kagan, Lawsuits and Litigants in Castile, 1500-1700, Chapel Hill, 1981.

(37) See Stone, Makers of Fortune. Note also that before 1900 the Auckland business elite lived in Auckland city; after that point it was more geographically dispersed.

(38) What makes imports as an index of prosperity unreliable for Nelson is that their per capita rate fell over the period while the standard of living almost certainly rose. At the national level, however, the trends

in the value of imports are a fairly reasonable index for the trends in the prosperity of New Zealand as a whole. External trade made up a larger portion of New Zealand's GDP than it did in almost every modern and modernising society over the period. C.G.F. Simkin, The Instability of a Dependent Economy: Economic Fluctuations in New Zealand 1840-1914, Oxford, 1951, took imports along with exports and circulating money as proxy measures for trends in the national income and found a reasonable concordance between all three. Ideally, we should have used a larger variety of indices of common living standards - such as unemployment, consumer prices, nominal wages, real wages - but the raw data for these are of very poor quality and quantity, especially at the provincial level.

(39) Note that beer consumption rate, police numbers per capita and men aged 21-40 were all higher than expected up to 1876; thereafter they were lower than expected relative to the global model.

(40) The time series plots indicate that this pattern was very strong up to about 1876 for all three variables. From 1876 however, beer consumption rate and the percentage of young males change over to being lower than expected; the percentage of adult females remains lower than expected, relative to the global model.

Appendix 1

Description of Variables Analysed

Percentage of Total Population who are Overseas-born Europeans
Percentage of Total Population who are Irish-born
Percentage of Total Population who are European Adult Males
Percentage of Total Population who are European Adult Females
Percentage of Total Population who are European and Urban
Percentage of Total Population who are Young European Males (aged 21-40 years)
European Dwellings 1-2 Rooms, per capita
European Total Dwellings, per capita
Spirits, Imperial Gallons Consumed, per capita
Beer, Imperial Gallons Consumed, per capita
Ratio of European Adult Males to Adult Females
European Dwellings, 1-2 Rooms, as a Ratio of Total Dwellings
Imports, pound per capita
Exports, pound per capita
Manufacturing Horse Power per capita
Percentage of Total Population who are Manufacturing Employees
Police Manpower, per 100,000 of Total Population
Immigration rate, per 100,000 of Total Population
Emigration rate, per 100,000 of Total Population
Drunkenness rate, summary convictions, per 100,000 of Total Populalation
Civil Suits tried and disposed of in the Magistrates' Courts, rate per 100,000 of Total Population
Violence rate, per 100,000 of Total Population

Notes: Details of the analysis period, population bases, and data sources can be found in Appendix 1 of Fairburn and Haslett (1986).